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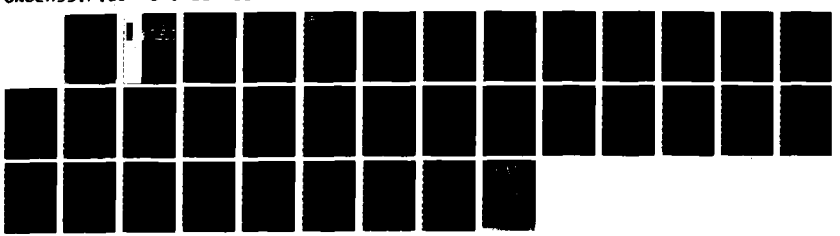

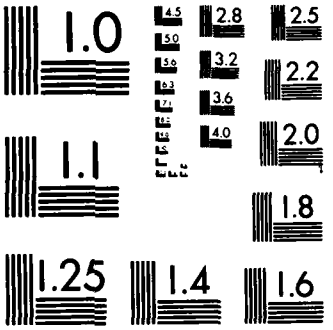

DEPOT TRANSPORTATION EFFICIENCY INDEX PERFORMANCE INDICATOR

DEPARTMENT OF DEFENSE

DEFENSE LOGISTICS AGENCY

Cameron Station,
Alexandria, Virginia 22304-6100

Operations Research and Economic Analysis Office

JANUARY 1987

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The Defense Logistics Agency Supply Operations Directorate, Transportation Division (DLA-OT), wishes to measure the depots' efficiency in consolidating Issue Priority Group (IPG) III items into freight shipments. This project investigated the consolidation system of IPG III materiel release orders (MROs) and the need to measure it at each depot with a single index. The report describes the process used to build an "efficiency index" to measure depot consolidation of IPG III MROs. Specifically, it details the selection of the factors used to construct the index, examines the behavior of each factor, describes the process used to develop a weighting scheme, and gives detailed instructions for computation of the actual index.

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Depot Transportation Efficiency Index Performance Indicator

January 1987

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Jan 87

FOREWORD

The Defense Logistics Agency's Directorate of Supply Operations, Transportation Division (DLA-OT) wishes to measure the depots' efficiency in consolidating Issue Priority Grouping (IPG) 3 items into freight shipments. This report looks at the consolidation system of IPG 3 Material Release Orders (MROs) and the need to measure it at each depot with a single index.

The report describes the process used to build an "efficiency index" to measure depot consolidation of IPG 3 MROs. Specifically it details the selection of the factors used to construct the index, examines the behavior of each factor, describes the process used to develop a weighting scheme, and gives detailed instructions for computation of the actual index.

The index is designed to be a relative indicator of an individual depot's consolidation performance. This is accomplished by establishing current and base periods and comparing the two using the index. Results of the comparison will revolve around the number 1. For example, if the result is less than 1 this indicates that consolidation for the current period is less efficient than consolidation in the base period. If the result is greater than 1 the opposite observation is made. For example, if a large increase or decrease is observed in the index, depot personnel will be alerted to possible problems or efficiencies in the consolidation process. Further investigation can then be conducted to isolate and correct the problem or note the area where efficiencies occurred.

We recommend that the index be adopted to measure the DLA depots consolidation of IPG 3 MROs scheduled for shipment.

ROGER C. ROY
Acting Assistant Director
Policy and Plans

CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

The Defense Logistics Agency's Directorate of Supply Operations, Transportation Division (DLA-OT), requested the development of an "Efficiency Index" to measure a depot's freight consolidation effectiveness for low priority requisitions. The index must use data from existing sources and only one index should be developed for use by all six DLA depots.

A. Background

Construction of an "Efficiency Index" to measure a depot's freight consolidation effectiveness depends on the way a Material Release Order (MRO) is received and processed by the depot system. Currently, the Mechanization of Warehousing and Shipment Processing (MOWASP) System is used by DLA to process MROs from receipt at a depot to delivery to a CONUS destination (customer, CCP or A/WPOE).

When a requisition is received into the system, it is assigned an Issue Priority Grouping (IPG), based on the Issue Priority Designator (IPD) assigned by the requisitioner. IPG 1 and 2 Materiel Release Orders (MRO) are treated as high priority requirements and are processed by the depot immediately upon receipt. Shipments with these priorities are accorded premium transportation, unless challenged and downgraded to a surface transportation mode. IPG 3 requisitions are considered low priority. MROs with this IPG are held in the depot computer "work load bank" for consolidation with other MROs having the same TAC 1 address to form multi-line Shipment Units (SU). These, in turn, are consolidated into common destination Transportation Units (TU) for forwarding on a single Government Bill of Lading to a common TAC 2 address. DoDAACs having the same TAC 2 address are linked by a common Destination Cross-Reference Code (DCR). Each DCR is assigned a Geographical Area Code (GAC) designed to link together DCRs that are the same number of intransit days from the depot. Normally IPG 3 MROs are "pulled" from the depot workload bank by GAC to satisfy depot workload requirements, or when MROs within that area must be processed to meet UMMIPS on-time performance standards. Successful workload leveling and effective freight consolidation are largely dependent upon the construction of the geographical areas. These should be constructed in such a manner as to provide combinations of MRO destinations that will, based on historical data, level the depots' daily workload and maximize the consolidation of IPG 3 MROs/SUs that are destined to the depots' major customers, by extending the bank time.

As shipment units are dropped from the bank they are processed (in a batch mode based on IPG) through the depot. Depot warehousing is divided into two basic units, bulk and bin. Processing, which consists of 'picking' the requisitioned stock from the appropriate location and packing it for forwarding by the selected transport mode, is accomplished within a 'standard' time established by the depot (normally two or three days for IPG 3 cargo). All IPG 3 SUs dropped from the bank on the same day are assigned the same Planned Date to Transportation (PDT). Because IPG 3 SUs are normally 'pulled' from the bank by GAC, the basic freight consolidation is actually done in the bank. If the grographical areas are properly constructed, and if depot processing standards are met, the separate SUs

with like DCRs will be 'offered' to the depot's transportation element on (or slightly before) their PDTs, and they will be consolidated into a single TU and forwarded to their common DCR on a single GBL.

The effectiveness of a depot's freight consolidation can be measured using variables such as the number of lines shipped as freight vice those shipped by small parcel carrier; the GBL weight; the number of bin lines forwarded as part of a freight (vice small parcel) shipment, and the number of all lines shipped by small parcel carriers. A single unit of measurement, which would include some of the above indicators, is necessary to measure each depot's freight consolidation effectiveness. DLA-OT plans to establish a moving base period of twelve months. Initially, the base will be the twelve month period immediately preceding the test month. On each succeeding month the latest month that has been measured will be added to the base, and the oldest month dropped. This replacement/updating of the base period will continue each succeeding month.

B. Purpose. To develop an "Efficiency Index" to measure each individual depot's freight consolidation effectiveness that is easy to use and understand.

C. Objectives. The following objectives were established and followed in accomplishing the study:

1. Identify and analyze the relationships between the various factors available for use in developing an index.

2. Establish a base period for study.

3. Develop an "Efficiency Index" which is simple to use and understand using factors readily available from existing sources. The factors should be those which most effectively represent the consolidation process and should be weighted so that more meaningful factors will have a greater impact on the index.

4. Design the index to show increases or decreases in a depot's freight consolidation efficiency. An upward movement would indicate improvement while a downward turn would alert the depot to possible problems in the consolidation process. Any significant movement in the index would require further investigation on the part of the depot.

D. Scope. The following assumptions and limitations apply to this study:

1. A 21-day processing standard for IPG 3 MROs was established at DLA depots in January 1986. This standard - which is the UMMIPS standard - measures the processing time from the date the MRO drops to the depot until the MRO materiel is offered for delivery at a CONUS destination (customer, A/WPOE or CCP). Prior to January 1986 DLA had unilaterally established a more stringent processing standard of 15 days for this priority group. It was increased to the UMMIPS standard because the additional bank time would permit depots to achieve a more balanced workload and, at the same time, increase freight consolidation economies.

2. Even though the index will be applied to all depots, only three depots were chosen to develop the index, they are: Memphis (DDMT) for its high workload; Richmond (DDRV) for its medium workload; and Columbus (DDCO) for its low workload.

II. METHODOLOGY

A. Review. Documents related to the MRO consolidation process were reviewed prior to beginning the study. They included the report of the six month test conducted at DDMT, DDOU, and DDTC[1] ; and the report concerning depot on-time standards[2].

B. Data Selection. Two requirements had to be met when selecting the data for constructing the index. First, data used to develop the index had to be representative of actual depot operations. This meant that a file which captured depot historical data elements representative of a depot's consolidation efficiency should be used. The other was the selection of a time frame that was relatively current and in the data base used. The Depot MRO History file was selected and data were extracted for the period August 1984 through July 1986.

C. Development of the Index. The best approach was determined to be a linear combination of several factors. These factors were selected by analysis as those best indicating the effectiveness of a depot's freight consolidation procedures.

D. Development of Weights. Weights were established by polling experts in depot operations and transportation at each of the six DLA depots. They ranked each of the selected factors by relative importance to the consolidation process on a scale of 1 to 10, with 10 being the highest rank and 1 the lowest rank. The weights, once established, are multiplied with each factor to reflect its relative importance in the overall index.

III. ANALYSIS

A. Selection of the Efficiency Index Factors. A number of data elements were reviewed as possible candidates for index factors. One of the key attributes required was that it would have to react, in a predictable manner, to fluctuations in consolidation effectiveness. Three elements that satisfied this requisite were selected to be index factors.

1. The average number of shipping unit lines per GBL. As more shipping unit lines are held in the computer bank for consolidation, the

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[1] Defense Logistics Agency, The Test for Reducing Depot/ Transportation Procurement Time for IPG 3 Requisitions, 31 March 1983.

[2] Defense Logistics Agency, Effect of Changing Depot On-Time Standards, December 1985.

larger the average number of lines per GBL will be. The average number of lines per GBL is calculated as follows:

$$\frac{\text{Total number of lines shipped by a GBL mode}}{\text{Total number of GBLs}}$$

2. The average weight per GBL. Similarly, the more lines included in a freight shipping unit, the heavier the average weight on the GBL. The average weight per GBL is calculated as follows:

$$\frac{\text{Total weight of GBLs issued}}{\text{Total number of GBLs}}$$

3. The ratio of BIN storage MRO lines sent by a freight mode to the number of such lines forwarded by a small parcel (non-BGL) mode. Finally, the number of lines consolidated into freight shipments are influenced by an increase in the ratio of BIN lines sent by freight vs the BIN lines sent by small parcel. This ratio is calculated as follows:

$$\frac{\text{Total number of BIN lines sent by freight}}{\text{Total number of BIN lines sent by small parcel}}$$

B. Formula for the Efficiency Index. The efficiency index is a linear combination of the above three factors. The following notation is necessary to understand the construction of the efficiency index. Let

A = the average GBL weight,

B = the average number of lines per GBL,

C = the ratio of BIN lines consolidated into freight,

b = the base to compare the current period against,

c = the current period,

W = the weight assigned to each factor (sum of the weights must be equal to 1), and

I = the efficiency index.

The efficiency index then would be represented as follows:

$$I = W_A \left(\frac{A_c}{A_b}\right) + W_B \left(\frac{B_c}{B_b}\right) + W_C \left(\frac{C_c}{C_b}\right)$$

C. Determination of the Period to be Measured

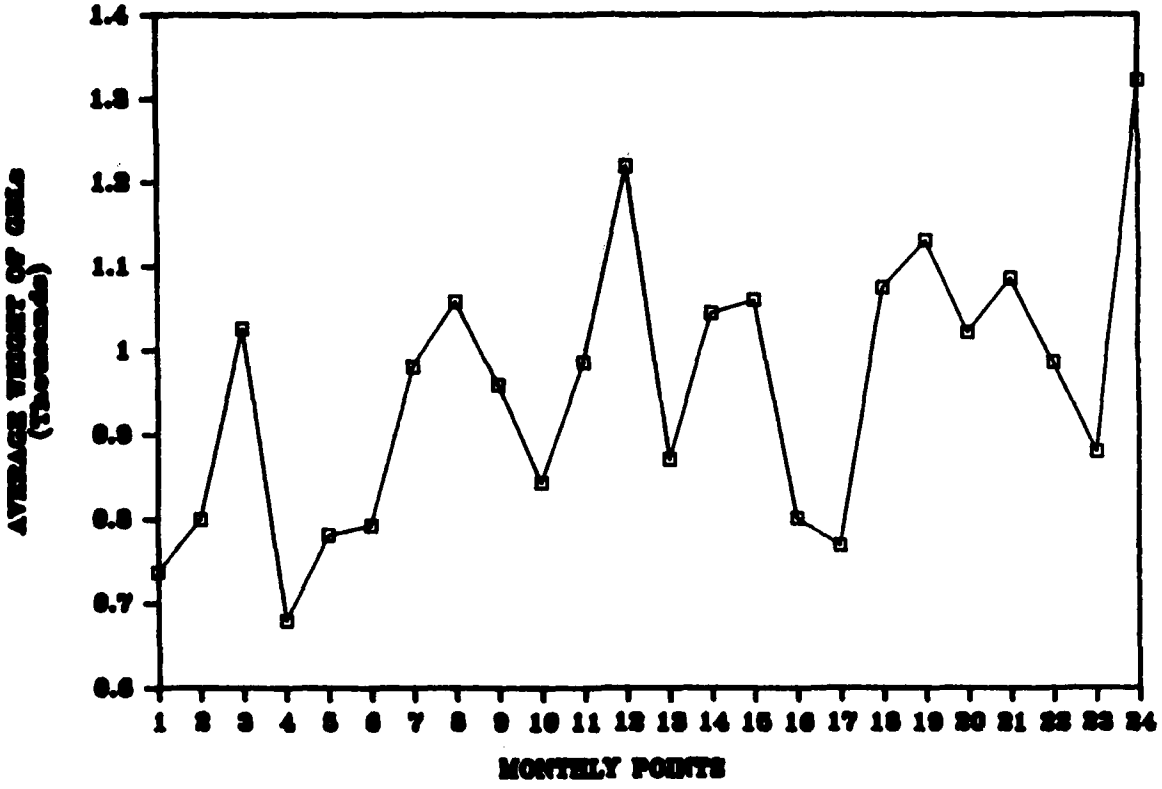
The factors were calculated for each month in our sample (August 1984 through July 1986) and curves were plotted. This was done for DDMT, DDRV, and DDCO. These plots showed peaks and valleys that we feel were caused by some of the following factors: a low demand for particular items stocked at a depot; seasonality; and, early drop of MROs from the bank to level the depot

workload. Figure 1 shows a plot by month of the average weight per GBL for DDCO. A regular upward trend can be seen.

To smooth out the seasonal and causal factors, moving averages were calculated and plots of the factors were made. We looked at three, four, five, and six month averages. Figures 2 and 3 represent the smoothing achieved for three and six months, respectively, for the average weight of GBLs at DDCO. Plots for the average number of lines/GBL and for the ratio of BIN lines sent by freight vs BIN lines sent by small parcel for DDCO are shown in Appendix A. Numbers used to calculate the moving averages are shown at Appendix B.

The selection of the six month period was based on the smoothness of the curve obtained at that period.

Figure 1. Average Weight of GBLs by Month - DDCO



Labels for the x-axis:

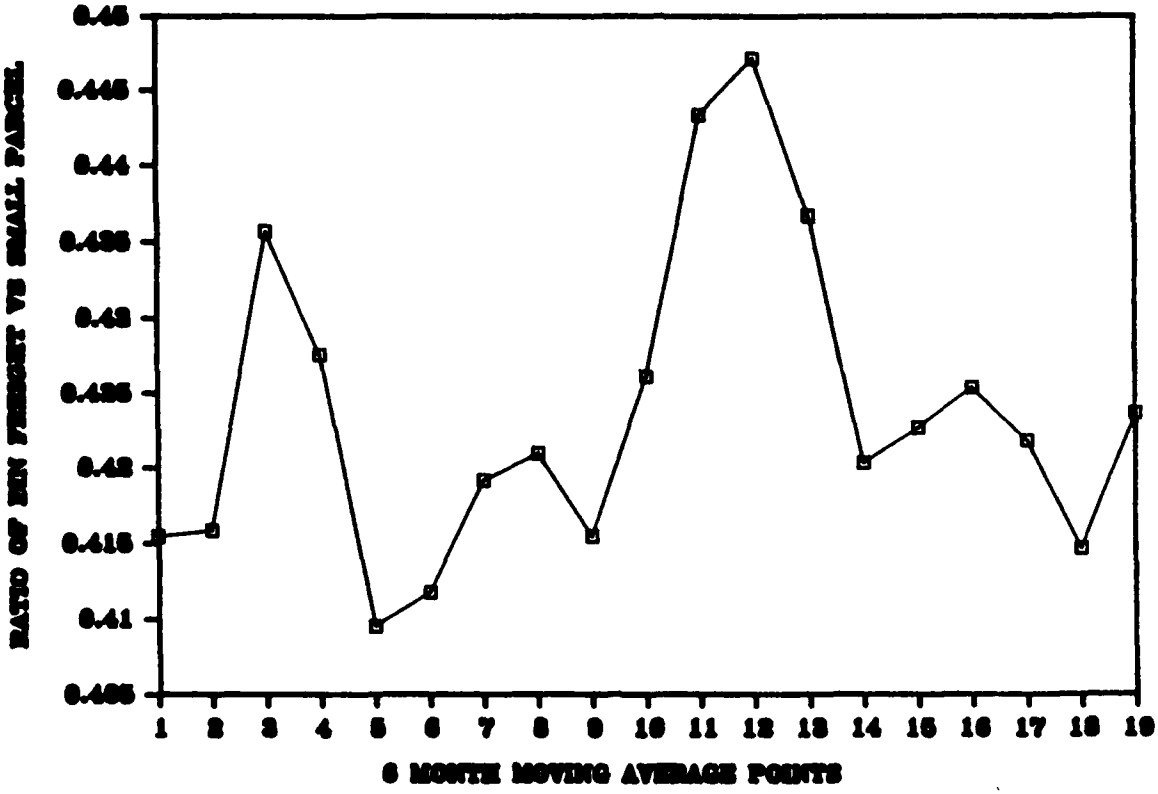
1:	Aug 84	13:	Aug 85
2:	Sep 84	14:	Sep 85
3:	Oct 84	15:	Oct 85
4:	Nov 84	16:	Nov 85
5:	Dec 84	17:	Dec 85
6:	Jan 85	18:	Jan 86
7:	Feb 85	19:	Feb 86
8:	Mar 85	20:	Mar 86
9:	Apr 85	21:	Apr 86
10:	May 85	22:	May 86
11:	Jun 85	23:	Jun 86
12:	Jul 85	24:	Jul 86

Figure 2. Average Weight of GBLs by Three Months - DDCO

Labels for the x-axis:

1:	Aug 84-Oct 84 average	12:	Jul 85-Sep 85 average
2:	Sep 84-Nov 84 average	13:	Aug 85-Oct 85 average
3:	Oct 84-Dec 84 average	14:	Sep 85-Nov 85 average
4:	Nov 84-Jan 85 average	15:	Oct 85-Dec 85 average
5:	Dec 84-Feb 85 average	16:	Nov 85-Jan 86 average
6:	Jan 85-Mar 85 average	17:	Dec 85-Feb 86 average
7:	Feb 85-Apr 85 average	18:	Jan 86-Mar 86 average
8:	Mar 85-May 85 average	19:	Feb 86-Apr 86 average
9:	Apr 85-Jun 85 average	20:	Mar 86-May 86 average
10:	May 85-Jul 85 average	21:	Apr 86-Jun 86 average
11:	Jun 85-Aug 85 average	22:	May 86-Jul 86 average

Figure 3. Average Weight of GBLs by Six Months - DDCO



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1:	Aug 84-Jan 85 average	10:	May 85-Oct 85 average
2:	Sep 84-Feb 85 average	11:	Jun 85-Nov 85 average
3:	Oct 84-Mar 85 average	12:	Jul 85-Dec 85 average
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5:	Dec 84-May 85 average	14:	Sep 85-Feb 86 average
6:	Jan 85-Jun 85 average	15:	Oct 85-Mar 86 average
7:	Feb 85-Jul 85 average	16:	Nov 85-Apr 86 average
8:	Mar 85-Aug 85 average	17:	Dec 85-May 86 average
9:	Apr 85-Sep 85 average	18:	Jan 86-Jun 86 average

19: Feb 86-Jul 86 average

D. Assignment of Weights

Fifteen respondents across the six depots (see Appendix C) gave their expert opinion on the relative importance of the three factors. They were requested to score each factor on a scale of 1 to 10 in order of importance (see Appendix D).

A Kruskal-Wallis one-way analysis of variance by ranks was used to determine the similarity of the scores for each factor. The null and alternative hypotheses are formulated as follows:

H_o: There is no difference among the scores assigned to the three factors.

H_a: At least one score differs from the others.

The test statistic H has a distribution that can be approximated to a chi-square distribution with k-1 degrees of freedom. H is formulated as follows:

$$H = \frac{12}{n(n+1)}\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} + \ldots + \frac{S_k^2}{n_3}\right) - 3(n+1)$$

where S_1 , S_2 , ... , S_k are the sums of the ranks and n_1 , n_2 , ... , n_k are the sample sizes for populations 1, ... ,k, respectively. For our study, k = 3 is the number of factors, $n_1 = n_2 = n_3 = 15$ are the number of respondents and $n = n_1 + n_2 + n_3$.

The critical value of chi-square with a = .05 and k-1 = 2 degrees of freedom is 5.99 (see the Percentage Points of the Chi-Square Distribution table at Appendix E). The value of H in our study is 3.037 which is less than 5.99; therefore, we do not reject the null hypothesis and we can say, with a confidence level of 95%, that there is no difference among the scores assigned to the three factors.

From the results of the above statistical test, we can conclude that there is no significant difference between the importance of the factors and the weights can therefore be assigned as 1/3 for each factor.

E. Use of the Index. The use of the index is described in the following 5 steps:

Step 1. Obtain the following information for the most recent twelve-month period:

- total number of GBLs.
- total number of freight lines.
- total GBL weight.
- total number of BIN shipping lines sent as small parcel.
- total number of BIN shipping lines consolidated into freight.

Step 2. Calculate the base period factors as follows:

Average weight per GBL = $\frac{\text{Total GBL weight}}{\text{Total number of GBLs}}$, denoted as A,

Average number of lines/GBL = $\frac{\text{Total \# of freight SULs}}{\text{Total number of GBLs}}$, denoted as B, and,

Ratio of BIN lines sent by freight vs BIN lines sent by small parcel = $\frac{\text{Total \# of BIN lines consolidated into freight}}{\text{Total \# of BIN lines sent as small parcel}}$, denoted as C.

This will constitute the initial base: A_b , B_b , C_b.

Step 3. Add the new month's information to the twelve month base period and drop the oldest month. This will be the new twelve month current period to compare against the base. Repeat steps 1 and 2 to calculate the new period: A_c , B_c , C_c.

Step 4. Calculate the efficiency index using the following linear equation:

$$I = \frac{1}{3}\left(\frac{A_c}{A_b}\right) + \frac{1}{3}\left(\frac{B_c}{B_b}\right) + \frac{1}{3}\left(\frac{C_c}{C_b}\right)$$

$$= \frac{1}{3}\left(\frac{A_c}{A_b} + \frac{B_c}{B_b} + \frac{C_c}{C_b}\right)$$

If I = 1 there is no change in efficiency;

If I < 1 there is a decrease in efficiency;

If I > 1 there is an increase in efficiency.

Step 5. The following month, use the current period compared, c, as the base period, b.

$$A_b = A_c$$

$$B_b = B_c$$

$$C_b = C_c$$

Repeat steps 3 and 4.

F. Validation. The weight validation will be a separate entity from this report. The efficiency index will be calculated for a selected six month period for each depot. The raw data will be sent to the experts who will be asked to rank the data from best to worst for consolidation efficiency. The results of the efficiency index computations for the same period will be ranked and comparisons will be made with the expert rankings of the raw data. The Spearman coefficient of rank correlation will be calculated to test the rankings association.

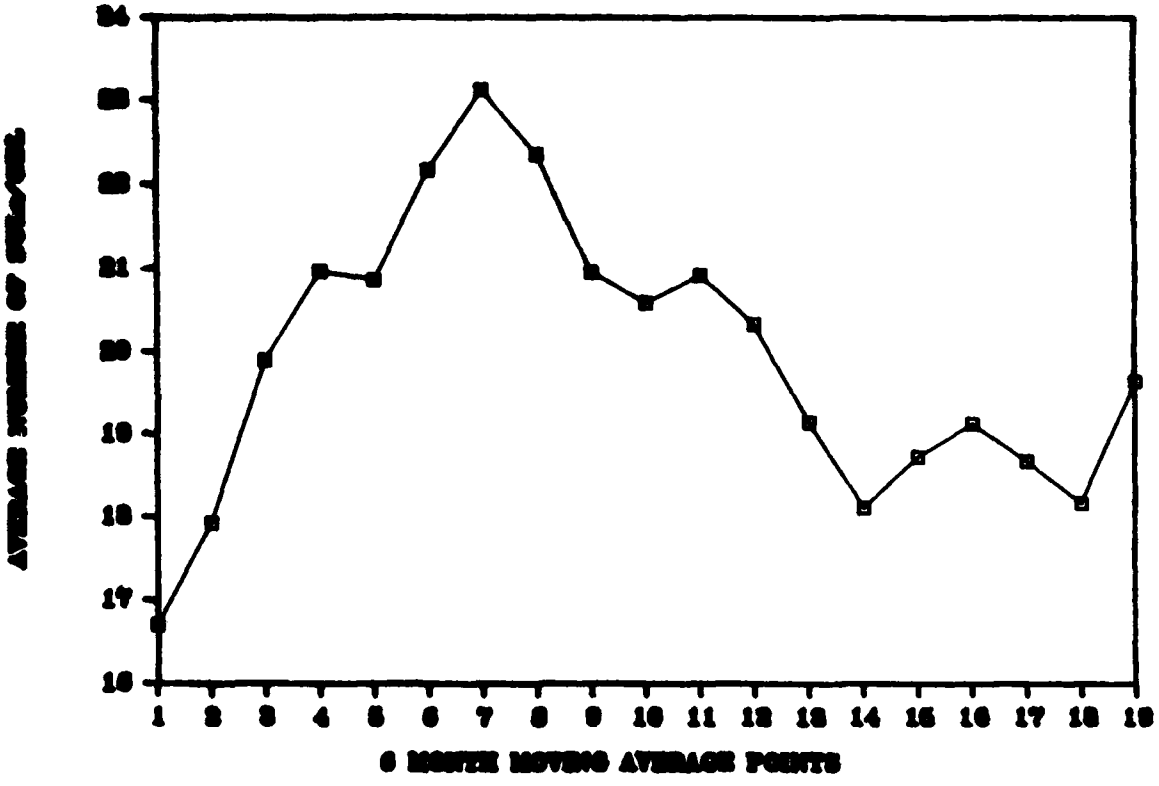
IV. CONCLUSIONS

The efficiency index is a relative indicator which provides a means to measure each depot's IPG 3 freight consolidation effectiveness. The index should be used only to measure a depot against its past performance. When enough index points have been computed, plots of the index may be used in conjunction with on-time performance to calculate an overall performance effectiveness rating.

APPENDIX A

PLOTS

Figure A-1. Average # of Lines/GBL by Six Months - DDCO



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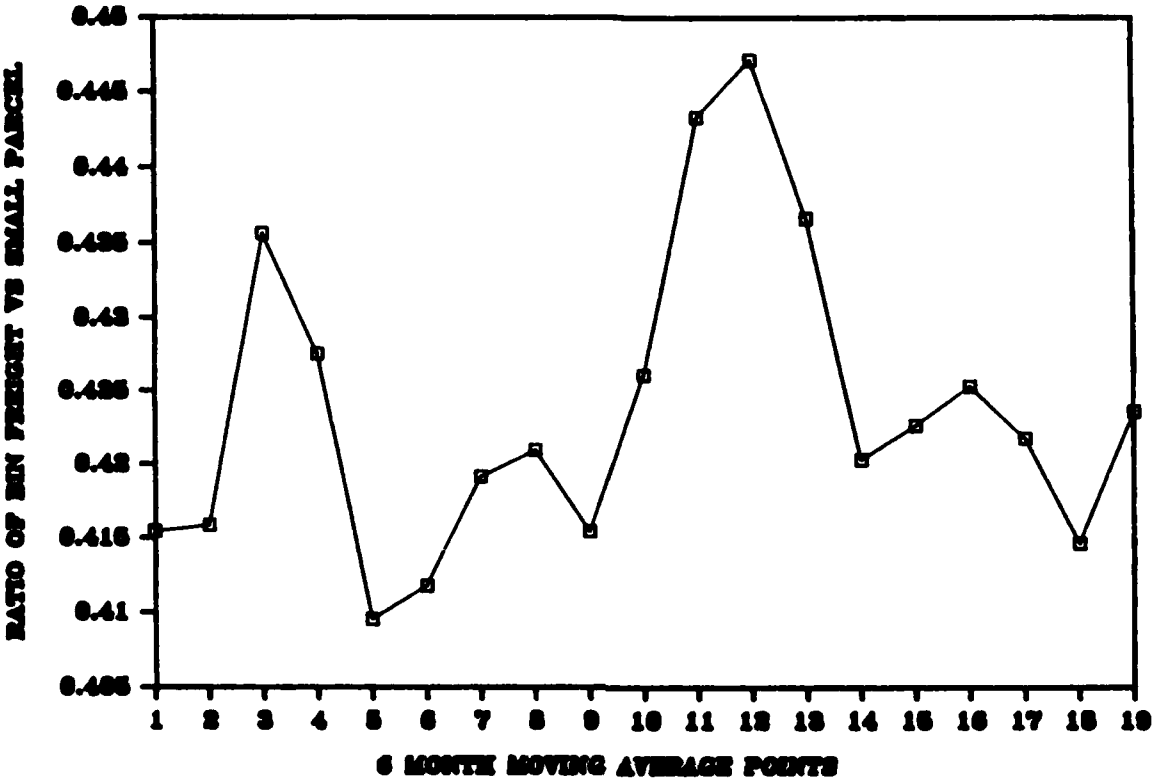
3:	Oct 84-Mar 85 average	12:	Jul 85-Dec 85 average
4:	Nov 84-Apr 85 average	13:	Aug 85-Jan 86 average
5:	Dec 84-May 85 average	14:	Sep 85-Feb 86 average
6:	Jan 85-Jun 85 average	15:	Oct 85-Mar 86 average
7:	Feb 85-Jul 85 average	16:	Nov 85-Apr 86 average
8:	Mar 85-Aug 85 average	17:	Dec 85-May 86 average
9:	Apr 85-Sep 85 average	18:	Jan 86-Jun 86 average

19: Feb 86-Jul 86 average

Figure A-2. Ratio of BIN Lines Sent by Freight by Six Months - DDCO



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8:	Mar 85-Aug 85 average	17:	Dec 85-May 86 average
9:	Apr 85-Sep 85 average	18:	Jan 86-Jun 86 average

19: Feb 86-Jul 86 average

APPENDIX B

Moving Averages Computations - DDCO

EFFICIENCY INDEX - DCSC

EFFICIENCY
INDEX

DCSC

	NUMBER OF GBLs	NUMBER OF LINES FREIGHT	TOTAL WEIGHT OF GBLs	NUMBER OF LINES BIN TO MAIL	NUMBER OF LINES BIN TO FREIGHT
AUG 84	3,139	53,532	2,317,266	97,606	[illegible]
SEP 84	2,637	37,856	2,111,283	87,547	[illegible]
OCT 84	2,843	46,155	2,919,741	90,[illegible]59	[illegible]
NOV 84	2,629	47,276	1,788,804	94,543	[illegible]
DEC 84	2,389	40,986	1,869,652	86,021	[illegible]
JAN 85	2,104	37,260	1,669,622	76,193	[illegible]
FEB 85	1,644	46,059	1,613,687	82,179	[illegible]
MAR 85	2,012	53,435	2,130,405	95,782	[illegible]
APR 85	2,073	44,616	1,989,259	98,611	[illegible]
MAY 85	2,133	35,648	1,800,835	88,243	[illegible]
JUN 85	1,777	43,331	1,753,105	86,191	[illegible]
JUL 85	1,827	42,160	2,228,579	74,610	[illegible]
AUG 85	2,370	53,426	2,066,370	89,687	[illegible]
SEP 85	2,389	44,355	2,497,783	73,668	[illegible]
OCT 85	2,292	44,503	2,432,599	74,81[illegible]	[illegible]
NOV 85	2,237	42,082	1,795,437	69,190	[illegible]
DEC 85	2,021	40,676	1,556,480	50,113	[illegible]
JAN 86	2,282	35,283	2,454,777	44,878	[illegible]
FEB 86	1,431	22,383	1,619,605	29,611	[illegible]
MAR 86	2,019	45,176	2,064,591	50,221	[illegible]
APR 86	2,014	44,128	2,188,639	49,717	[illegible]
MAY 86	2,448	40,551	2,415,570	49,558	[illegible]
JUN 86	2,001	34,146	1,763,303	41,415	[illegible]
JUL 86	1,360	35,265	1,798,575	40,639	[illegible]

EFFICIENCY INDEX - DCSC

POINTS FOR MONTHLY COMPARISONS

	AVERAGE NUMBER OF LINES/GBLs	AVERAGE WEIGHT OF GBLs	RATIO OF BIN LINES FREIGHT VS MAIL
AUG 84	17	738	0.4635
SEP 84	14	801	0.3542
OCT 84	16	1,027	0.4189
NOV 84	18	680	0.4332
DEC 84	17	783	0.4030
JAN 85	18	794	0.4128
FEB 85	28	982	0.4751
MAR 85	27	1,059	0.4678
APR 85	22	960	0.3765
MAY 85	17	844	0.3260
JUN 85	24	987	0.4168
JUL 85	23	1,220	0.4649
AUG 85	23	872	0.4810
SEP 85	19	1,046	0.4437
OCT 85	19	1,061	0.4335
NOV 85	19	803	0.4150
DEC 85	20	770	0.4304
JAN 86	15	1,076	0.3826
FEB 86	16	1,132	0.3822
MAR 86	22	1,023	0.4694
APR 86	22	1,087	0.4548
MAY 86	17	987	0.3912
JUN 86	17	881	0.3865
JUL 86	26	1,322	0.4369

EFFICIENCY INDEX - DCSC

THREE MONTH AVERAGES

	NUMBER OF GBLs	NUMBER OF LINES FREIGHT	TOTAL WEIGHT OF GBLs	NUMBER OF LINES BIN TO MAIL	NUMBER OF LINES BIN TO FREIGHT
AUG 84-OCT 84	2,873	45,848	2,449,430	91,804	38,021
SEP 84-NOV 84	2,703	43,762	2,273,276	90,783	36,[illegible]
OCT 84-DEC 84	2,620	44,806	2,192,732	90,274	37,[illegible]
NOV 84-JAN 85	2,374	41,841	1,776,026	85,586	33,[illegible]
DEC 84-FEB 85	2,046	41,435	1,717,654	81,461	32,[illegible]
JAN 85-MAR 85	1,920	45,585	1,804,571	84,715	38,[illegible]
FEB 85-APR 85	1,910	48,037	1,911,117	92,188	40,[illegible]
MAR 85-MAY 85	2,073	44,566	1,973,500	94,212	34,[illegible]
APR 85-JUN 85	1,994	41,198	1,847,733	91,015	37,[illegible]
MAY 85-JUL 85	1,912	40,380	1,927,506	83,015	33,[illegible]
JUN 85-AUG 85	1,991	46,306	2,016,018	83,563	37,[illegible]
JUL 85-SEP 85	2,195	46,647	2,264,244	79,388	34,[illegible]
AUG 85-OCT 85	2,350	47,428	2,332,251	79,456	34,[illegible]
SEP 85-NOV 85	2,306	43,647	2,241,940	72,557	31,[illegible]
OCT 85-DEC 85	2,183	42,420	1,928,172	64,705	27,[illegible]
NOV 85-JAN 86	2,180	39,347	1,935,565	54,727	22,[illegible]
DEC 85-FEB 86	1,911	32,781	1,876,954	41,534	16,[illegible]
JAN 86-MAR 86	1,911	34,281	2,046,324	41,570	17,[illegible]
FEB 86-APR 86	1,821	37,229	1,957,612	43,183	19,[illegible]
MAR 86-MAY 86	2,160	43,285	2,222,933	49,832	21,[illegible]
APR 86-JUN 86	2,154	39,608	2,122,504	46,897	19,[illegible]
MAY 86-JUL 86	1,936	36,654	1,992,483	43,871	17,[illegible]

EFFICIENCY INDEX - DCSC

THREE MONTH MOVING AVERAGE FACTORS

	AVERAGE NUMBER OF LINES/GBLs	AVERAGE WEIGHT OF GBLs	RATIO OF BIN LINES FREIGHT VS MAIL
AUG 84-OCT 84	16	853	0.4142
SEP 84-NOV 84	16	841	0.4031
OCT 84-DEC 84	17	837	0.4188
NOV 84-JAN 85	18	748	0.4170
DEC 84-FEB 85	20	840	0.4303
JAN 85-MAR 85	24	940	0.4537
FEB 85-APR 85	25	1,001	0.4374
MAR 85-MAY 85	22	952	0.3917
APR 85-JUN 85	21	926	0.3729
MAY 85-JUL 85	21	1,008	0.3990
JUN 85-AUG 85	23	1,012	0.4541
JUL 85-SEP 85	21	1,031	0.4644
AUG 85-OCT 85	20	992	0.4545
SEP 85-NOV 85	19	972	0.4310
OCT 85-DEC 85	19	883	0.4261
NOV 85-JAN 86	18	888	0.4108
DEC 85-FEB 86	17	982	0.4017
JAN 86-MAR 86	18	1,071	0.4174
FEB 86-APR 86	20	1,075	0.4438
MAR 86-MAY 86	20	1,029	0.4386
APR 86-JUN 86	18	985	0.4123
MAY 86-JUL 86	19	1,029	0.4038

EFFICIENCY INDEX - DCSC

SIX MONTH AVERAGES

	NUMBER OF GBLs	NUMBER OF LINES FREIGHT	TOTAL WEIGHT OF GBLs	NUMBER OF LINES BIN TO MAIL	NUMBER OF LINES BIN TO FREIGHT
AUG 84-JAN 85	2,624	43,844	2,112,728	88,695	36,357
SEP 84-FEB 85	2,374	42,599	1,995,465	86,122	35,877
OCT 84-MAR 85	2,270	45,195	1,998,652	87,495	36,153
NOV 84-APR 85	2,142	44,939	1,843,572	88,887	35,611
DEC 84-MAY 85	2,059	43,001	1,845,577	87,837	35,977
JAN 85-JUN 85	1,957	43,392	1,826,152	87,865	36,157
FEB 85-JUL 85	1,911	44,208	1,919,312	87,601	36,721
MAR 85-AUG 85	2,032	45,436	1,994,759	88,887	37,427
APR 85-SEP 85	2,095	43,923	2,055,989	85,202	35,403
MAY 85-OCT 85	2,131	43,904	2,129,879	81,235	34,621
JUN 85-NOV 85	2,149	44,976	2,128,979	78,060	34,617
JUL 85-DEC 85	2,189	44,534	2,096,208	72,047	32,[illegible]
AUG 85-JAN 86	2,265	43,388	2,133,908	67,092	29,309
SEP 85-FEB 86	2,109	38,214	2,059,447	57,046	25,981
OCT 85-MAR 86	2,047	38,351	1,987,248	53,138	22,465
NOV 85-APR 86	2,001	38,288	1,946,588	48,955	21,[illegible]
DEC 85-MAY 86	2,036	38,033	2,049,944	45,683	19,[illegible]
JAN 86-JUN 86	2,033	36,945	2,084,414	44,233	18,[illegible]
FEB 86-JUL 86	1,879	36,942	1,975,047	43,527	18,[illegible]

EFFICIENCY INDEX - DCSC

SIX MONTH MOVING AVERAGE FACTORS

	AVERAGE NUMBER OF LINES/GBLs	AVERAGE WEIGHT OF GBLs	RATIO OF BIN LINES FREIGHT VS MAIL
AUG 84-JAN 85	17	805	0.4156
SEP 84-FEB 85	18	840	0.4160
OCT 84-MAR 85	20	880	0.4357
NOV 84-APR 85	21	861	0.4276
DEC 84-MAY 85	21	896	0.4096
JAN 85-JUN 85	22	933	0.4118
FEB 85-JUL 85	23	1,004	0.4192
MAR 85-AUG 85	22	982	0.4210
APR 85-SEP 85	21	981	0.4155
MAY 85-OCT 85	21	999	0.4262
JUN 85-NOV 85	21	991	0.4434
JUL 85-DEC 85	20	957	0.4472
AUG 85-JAN 86	19	942	0.4367
SEP 85-FEB 86	18	977	0.4204
OCT 85-MAR 86	19	971	0.4227
NOV 85-APR 86	19	973	0.4254
DEC 85-MAY 86	19	1,007	0.4218
JAN 86-JUN 86	18	1,026	0.4147
FEB 86-JUL 86	20	1,051	0.4237

APPENDIX C

List of Experts

List of Experts

Mr. Don Lindke, DDMP-T

Ms. Janet Cravener, DDMP-T

Ms. Nan Merrill, DDMP-TT

LTC D. Schreen, DDCO-TT

Maj M. Curley, DDRV-TT

Mr. John LaFemina, DDRV-TT

Ms. Toni Harris, DDRV-T

Ms. Betty Perry, DDMT-TT

Ms. Gwen Garrett, DDMT-Q

LTC E. Buck, DDTC-TT

Mr. Lloyd Cabezut, DDTC-TT

Mr. Oscar Nolan, DDTC-T

Mr. Rick Hanson, DDOU-T

LTC G. Wimer, DDOU-TT

Mr. William Besser, DDOU-TT

APPENDIX D

Experts Rankings

Experts Rankings

Expert	Factor 1	Factor 2	Factor 3
A	3	3	3
B	5	8	6
C	8	5	3
D	10	5	8
E	10	7	1
F	8	2	8
G	6	8	10
H	7	9	10
I	1	8	5
J	6.5	10	5
K	5	1	4
L	10	10	10
M	10	10	4
N	10	8	2
O	10	5	1

where factor 1 = $\frac{\text{Total Weight of GBLs Issued}}{\text{Total Number of GBLs}}$

factor 2 = $\frac{\text{Total Number of Lines Shipped}}{\text{Total Number of GBLs}}$

factor 3 = $\frac{\text{Total Number of BIN Lines Sent by Freight}}{\text{Total Number of BIN Lines Sent by Small Parcel}}$

APPENDIX E

Percentage Points of The Chi-Square Distribution Table

Percentage Points of the Chi-Square Distribution

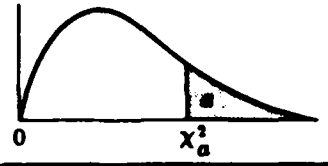

TABLE E-1

d.f.	$a = .995$	$a = .990$	$a = .975$	$a = .950$	$a = .900$	$a = .10$	$a = .05$	$a = .025$	$a = .010$	$a = .005$	d.f.
1	0.0000393	0.0001571	0.0009821	0.0039321	0.0157908	2.70554	3.84146	5.02389	6.63490	7.87944	1
2	0.0100251	0.0201007	0.0506356	0.102587	0.210720	4.60517	5.99147	7.37776	9.21034	10.5966	2
3	0.0717212	0.114832	0.215795	0.351846	0.584375	6.25139	7.81473	9.34840	11.3449	12.8381	3
4	0.206990	0.297110	0.484419	0.710721	1.063623	7.77944	9.48773	11.1433	13.2767	14.8602	4
5	0.411740	0.554300	0.831211	1.145476	1.61031	9.23635	11.0705	12.8325	15.0863	16.7496	5
6	0.675727	0.872085	1.237347	1.63539	2.20413	10.6446	12.5916	14.4494	16.8119	18.5476	6
7	0.989265	1.239043	1.68987	2.16735	2.83311	12.0170	14.0671	16.0128	18.4753	20.2777	7
8	1.344419	1.646482	2.17973	2.73264	3.48954	13.3616	15.5073	17.5346	20.0902	21.9550	8
9	1.734926	2.087912	2.70039	3.32511	4.16816	14.6837	16.9190	19.0228	21.6660	23.5893	9
10	2.15585	2.55821	3.24697	3.94030	4.86518	15.9871	18.3070	20.4831	23.2093	25.1882	10
11	2.60321	3.05347	3.81575	4.57481	5.57779	17.2750	19.6751	21.9200	24.7250	26.7569	11
12	3.07382	3.57056	4.40379	5.22603	6.30380	18.5494	21.0261	23.3367	26.2170	28.2995	12
13	3.56503	4.10691	5.00874	5.89186	7.04150	19.8119	22.3621	24.7356	27.6883	29.8194	13
14	4.07468	4.66043	5.62872	6.57063	7.78953	21.0642	23.6848	26.1190	29.1413	31.3193	14
15	4.60094	5.22935	6.26214	7.26094	8.54675	22.3072	24.9958	27.4884	30.5779	32.8013	15
16	5.14224	5.81221	6.90766	7.96164	9.31223	23.5418	26.2962	28.8454	31.9999	34.2672	16
17	5.69724	6.40776	7.56418	8.67176	10.0852	24.7690	27.5871	30.1910	33.4087	35.7185	17
18	6.26481	7.01491	8.23075	9.39046	10.8649	25.9894	28.8693	31.5264	34.8053	37.1564	18
19	6.84398	7.63273	8.90655	10.1170	11.6509	27.2036	30.1435	32.8523	36.1908	38.5822	19
20	7.43386	8.26040	9.59083	10.8508	12.4426	28.4120	31.4104	34.1696	37.5662	39.9968	20
21	8.03366	8.89720	10.28293	11.5913	13.2396	29.6151	32.6705	35.4789	38.9321	41.4010	21
22	8.64272	9.54249	10.9823	12.3380	14.0415	30.8133	33.9244	36.7807	40.2894	42.7956	22
23	9.26042	10.19567	11.6885	13.0905	14.8479	32.0069	35.1725	38.0757	41.6384	44.1813	23
24	9.88623	10.8564	12.4011	13.8484	15.6587	33.1963	36.4151	39.3641	42.9798	45.5585	24
25	10.5197	11.5240	13.1197	14.6114	16.4734	34.3816	37.6525	40.6465	44.3141	46.9278	25
26	11.1603	12.1981	13.8439	15.3791	17.2919	35.5631	38.8852	41.9232	45.6417	48.2899	26
27	11.8076	12.8786	14.5733	16.1513	18.1138	36.7412	40.1133	43.1944	46.9630	49.6449	27
28	12.4613	13.5648	15.3079	16.9279	18.9392	37.9159	41.3372	44.4607	48.2782	50.9933	28
29	13.1211	14.2565	16.0471	17.7083	19.7677	39.0875	42.5569	45.7222	49.5879	52.3356	29
30	13.7867	14.9535	16.7908	18.4926	20.5992	40.2560	43.7729	46.9792	50.8922	53.6720	30
40	20.7065	22.1643	24.4331	26.5093	29.0505	51.8050	55.7585	59.3417	63.6907	66.7659	40
50	27.9907	29.7067	32.3574	34.7642	37.6886	63.1671	67.5048	71.4202	76.1539	79.4900	50
60	35.5346	37.4848	40.4817	43.1879	46.4589	74.3970	79.0819	83.2976	88.3794	91.9517	60
70	43.2752	45.4418	48.7576	51.7393	55.3290	85.5271	90.5312	95.0231	100.425	104.215	70
80	51.1720	53.5400	57.1532	60.3915	64.2778	96.5782	101.879	106.629	112.329	116.321	80
90	59.1963	61.7541	65.6466	69.1260	73.2912	107.565	113.145	118.136	124.116	128.299	90
100	67.3276	70.0648	74.2219	77.9295	82.3581	118.498	124.342	129.561	135.807	140.169	100

END

10-87

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